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(54) Anaesthetic filter arrangement

(57) An anaesthetic filter arrangement comprises a filter housing (2) having openings (4,6) disposed to delimit a gas flow path (4,8,6) internal of the housing (2) for gas passing to and from a patient and having disposed within the gas flow path (4,8,6) a filter element (10) formed of an adsorption material for the alternate adsorption and desorption of gaseous anaesthetic from and into gas passing along the gas flow path (4,8,6) respectively from and to the patient. An energy source (12,18) is provided to supply thermal (and/or vibrational) energy at the filter element (10) to vary retention of the gaseous anaesthetic by the filter element (10).

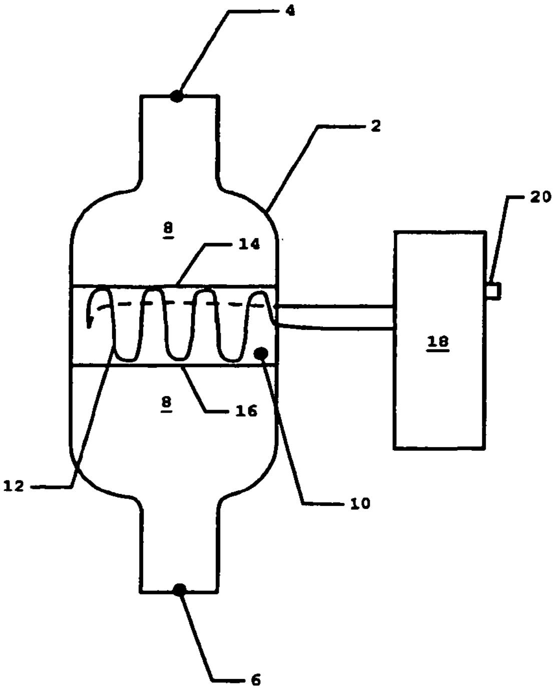

Fig. 1

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Description

[0001] The present invention relates to an anaesthetic filter arrangement and in particular to a filter arrangement for the re-use of anaesthetics in inhalation anaesthesia.

[0002] Filter arrangements for the re-use of gaseous anaesthetics are well known and are described in, for example US 5,044,361 and US 5,471,979. These filter arrangements generally comprise a filter housing in which there are provided openings delimiting a gas flow path through the interior of the housing. Disposed within the gas flow path is a filter element of an adsorption material for the alternate adsorption and desorption of gaseous anaesthetic from and into gas passing along the flow path. These filters are placed within gas flow circuits of anaesthetic ventilator systems so that anaesthetic rich gas which is exhaled by a patient into the gas flow circuit during an expiration phase passes through the filter element along the flow path in one flow direction and so that breathing gas in the gas flow circuit which is to be supplied to the patient during an inspiration phase passes through the filter element along the flow path, usually but not necessarily, in the opposite flow direction. The filter element adsorbs gaseous anaesthetic from the exhaled gas then desorbs this adsorbed gaseous anaesthetic into the breathing gas.

[0003] Such filter arrangements suffer from the disadvantage that their retention properties for the gaseous anaesthetic are fixed, dependent on the adsorption and desorption characteristics of the filter element material. Adsorption and desorption of gaseous anaesthetic to and from the filter element is then largely controlled by varying the flow of and to a lesser extent the concentration of gaseous anaesthetic in gas passing along the gas flow path, through the filter element. However, varying these gas flow and concentration parameters may have undesirable effects on the ventilation of a patient who is connected to an anaesthetic ventilator system in which the filter arrangement is disposed.

[0004] According to a first aspect of the present invention there is provided an anaesthetic filter arrangement as disclosed in and characterised by the present claim 1. The retention of gaseous anaesthetic by the filter element is thus varied through supplying either thermal or vibrational energy, at the element which thereby varies the adsorption and/or desorption of gaseous anaesthetic.

[0005] The thermal energy may be supplied to the filter element using an energy source comprising a resistive heater element, for example formed of a thin wire, which can be placed in intimate thermal contact with the filter element, for example within the volume of the element material.

[0006] Alternatively, the material of the filter element may be electrically conducting, for example activated carbon material, and used as the resistive heater element. This has the advantage that the thermal energy can be evenly distributed throughout the entire volume of the filter element without the need for integrating a separate resistive heater element.

[0007] Usefully, an electromagnetic energy source, such as an infrared or microwave source may be employed to supply the thermal energy at the element. This has an advantage that the source may be located remote from the filter element which permits the use of a disposable filter element without the need to also dispose of components of the energy source.

[0008] A source of vibrational energy, such as an acoustic, preferably ultrasonic, vibrational energy source, may be employed as the energy source. This has the advantage that the vibrational energy can be supplied from outside the filter housing, for example by using vibrational sources detachably mounted to an external surface of the housing. This permits the re-use of the vibrational sources when used with disposable filter elements and housings and also the ready modification of existing filter housings.

[0009] Exemplary embodiments of the present invention will now be described with reference to the drawings of the accompanying figures, of which:

Fig. 1 shows an embodiment of a filter arrangement according to the present invention;
Fig. 2 shows a further embodiment of a filter arrangement according to the present invention; and
Fig. 3 shows an inhalation anaesthetic system including as an element thereof a filter arrangement according to the present invention.

[0010] Considering now Fig. 1, an anaesthetic filter arrangement is shown comprising a filter housing 2 in which is provided openings 4,6 for leading a gas to and from the interior 8 of the housing 2. Contained within the interior 8 of the housing 2 in a gas flow path delimited by the openings 4,6 is a filter element 10 formed of a suitable adsorption material such as zeolites of crystalline aluminium silicates which may be pellets or supported on a carrier; or an activated carbon filter such as formed from carbon-impregnated material, carbon fibre cloth, or granulated or microporous carbon material.

[0011] A resistive heater element 12 consisting of a thin electrical conductor is, in the present embodiment, provided within the volume of the filter element 10. This heater element 12 may alternatively be disposed across one or both outer surfaces 14,16 of the filter element 10 and may even be utilised as a carrier for the adsorption material from which the element 10 is formed provided that passage of gas through the filter element 10 is not significantly inhibited. If an activated charcoal material is used in the filter element 10 then the carbon material itself can be used as the resistive heater element and the separate element 12 is not required.

[0012] A supply 18 is also provided to energise the heater element 12 (or the filter element material directly) to supply thermal energy for weakening any bond between adsorbed gaseous anaesthetic and the material of the filter element 10. In this manner desorption may be promoted or adsorption inhibited, dependent on when the energy is supplied. This power supply is here provided with an interface 20 for receiving control signals which are employed to vary one or both of the level and the duration of the power supplied to the heater element 12 from the supply 18. It will be appreciated that the nature of this control signal is largely a design choice and may be originated for example by a flow meter located in a gas flow path outside but connected to the openings 4,6 of the housing 2 and may be used to synchronise the supply of power with a gas flow, as will be described in greater detail below. Other control forms (not shown) for example internal timing circuitry or simply a manual control such as a manually variable resistor or an on/off switch may be additionally or alternatively used to vary the level and/or duration of power supplied by the supply 18.

[0013] Considering now the arrangement of Fig. 2, a filter housing 22 which is provided openings 24,26 for leading a gas to and from the interior 28 of the housing 22. Sealing rings 30,32 are provided towards the ends of the openings 24,26, distal the interior 28 of the housing 22. These rings 30,32 are intended to form a releasable gas tight seal with a push fit conduit 34 inside which is contained a flow meter 36. The conduit 34 is shown in this example to be connected to the opening 26 of the housing but could be connected to the opposing opening 24.

[0014] Contained within the interior 28 of the housing 22 is a filter element 38 formed of a suitable adsorption material which may or may not be that material used in the arrangement of Fig. 1.

[0015] A pair of conventional ultrasonic emitters 40, such as are formed from piezoelectric discs, are releasably located facing one another in intimate contact to the outside of the housing 22 using retaining means 42 so as to be able to direct ultrasonic waves into the interior 28 of the housing 22, towards the filter element 38. Preferably, the emitters 40 are positioned to overlay the volume of the housing 22 which, in use, contains the filter element 38. Optionally, thin vibratable rods 44 may be usefully employed, as in the present embodiment, to enhance the transfer of vibrational energy from the emitters 40 into the bulk of the filter element 38. These rods 44 are preferably dimensioned to have a resonant frequency at or close to the frequency of ultrasound generated by the emitters 40.

[0016] A power supply 46 is connected to energise the emitters 40 and is provided with an interface 48 for receiving control signals from the flow meter 36. These signals are employed by the power supply 46 to vary the power supplied to the emitters 40,42. The flow meter 36 preferably provides a control signal to the interface 48 which is indicative of the direction of gas flow in the conduit 34 and the power supply 46 is adapted to respond to the control signal by starting or stopping the supply of power to the emitters 40 dependent on the flow direction. It will be appreciated from the following description of the use of the filter arrangement according to the present invention in the inhalation anaesthetic system of Fig. 3 that the flow meter 36 may be substituted for a flow meter commonly found is such systems and used to control a breathing gas supply.

[0017] Considering now the anaesthetic inhalation system of Fig. 3. An anaesthetic filter arrangement 50 according to the present invention, being in the present embodiment the arrangement described above in respect of Fig. 2, is disposed with the openings 24,26 connected in-line in a gas conduit 52a,b which has a section 52a having an open end 54 for connection to the airways of a patient (not shown) and a section 52b which connects via a 'Y-Piece' 56 to a conventional mechanical breathing device 58, in this example a mechanical ventilator, which is used to provide a breathing gas to the patient. The section 52b also connects via the Y-Piece 56 to atmosphere or to a gas collection system (not shown). The latter typically via a dedicated gas flow conduit in the ventilator 58. A conventional anaesthetic evaporator 60 is connected to the section of gas conduit 52a via an outlet 62 located between the open end 54 of the conduit 52a and the filter housing 22 of the filter arrangement 50. The output of the evaporator is, in the present embodiment, controlled dependent on a desired anaesthetic concentration, for example provided to the evaporator by a user, and a concentration of anaesthetic in a breathing gas flowing in the conduit 52a, towards the patient. This latter concentration is conveniently monitored by a conventional concentration meter 64 which is preferably located between the outlet 62 and the filter housing 22 to monitor the concentration of anaesthetic already in the breathing gas after passage through the filter element 38 of the filter arrangement 50.

[0018] In use anaesthetic rich gas is exhaled by the patient during an expiration phase into the conduit 52a where it flows via the opening 24 of the filter housing 22 through the filter element 38 which adsorbs gaseous anaesthetic from the gas. The gas then continues to flow along a flow path within the housing 22 and exits into the gas conduit 52b via the opening 26. At the Y-Piece 56 a one-way valve 66 prevents the exhaled gas from flowing towards the ventilator 58 and the gas passes through a second one-way valve 68 to atmosphere (or to a gas collection system if present).

[0019] It will be appreciated by those skilled in the art that the known ventilator 58 includes flow control valves as part of the breathing circuit within the ventilator which operate to regulate the supply of breathing gas and which are closed during the expiration phase so that the one-way valve 66 may be omitted. Indeed, similar flow control valves are often used to regulate the flow of exhaled gas if it passes through a gas flow path within the ventilator 58 and are closed during the supply of the breathing gas so that the one-way valve 68 may, in this circumstance, also be omitted.

[0020] In the present embodiment, the ventilator 58 operates during an inspiration phase to supply breathing gas via the one-way valve 66 and the Y-Piece 56 into the gas conduit 52b. The breathing gas then flows via the opening 26 through the filter element 38 where previously adsorbed gaseous anaesthetic is desorbed into the breathing gas. The breathing gas flows out of the filter housing 22 via the opening 24 and into the gas conduit 52a where the anaesthetic meter 64 measures the concentration of anaesthetic and provides an indication of the same to the anaesthetic evaporator 60 which uses the information to control the supply of anaesthetic to the outlet 62 in order to achieve a desired anaesthetic concentration in the breathing gas at the open end 54 of the gas conduit 52a.

[0021] As the breathing gas flows in the conduit 52b towards the opening 26 of the filter housing 22 it flows through the conduit 34 where the flow meter 36 registers at least the direction of flow and may also measure the magnitude of flow. These flow parameters can also be provided to the ventilator 58 (broken line connection in Fig. 3) where they may be employed to regulate the supply of breathing gas. Usually, in known inhalation anaesthetic systems, a flow meter is provided to at least monitor the supply of breathing gas from the ventilator 58. It will be appreciated by those skilled in the art that the flow meter 36 of the filter arrangement 50 may be substituted for the flow meter of the anaesthetic system, if provided. The advantage of providing a separate flow meter 36, as illustrated in the present embodiment, is that the filter arrangement 50 may be provided as a "stand-alone" device, operable independent of any anaesthetic system in which it is connected.

[0022] A control signal indicating at least the direction of flow is passed from the flow meter 36 to the interface 48 of the power supply 46. The power supply 46 is adapted to energise the ultrasound emitters 40 of the filter arrangement 50 when the control signal indicates a flow of breathing gas from the ventilator 58, towards the filter housing 22. In addition the level of power supplied by the supply 46 to the emitters 40 may be varied dependent on the magnitude of the flow, as measured by the flow meter 36. The ultrasound energy emitted by the emitters 40 causes the filter element 38 and any adsorbed gaseous anaesthetic to vibrate and thus promotes the desorption of the gaseous anaesthetic into the breathing gas as it flows through the filter element 38. The operation of the energy supply 46 may also be made dependent on the output from the concentration meter 64 (broken line connection in Fig. 3) such that, for example, the level of energy supplied to the emitters 40 is reduced as the measured concentration approaches the desired value.

[0023] In order to achieve a greater uptake of anaesthetic by the patient it is advantageous to desorb a greater amount of the adsorbed gaseous anaesthetic in to the breathing gas at the commencement of its supply to the patient so that the anaesthetic gas can reach deep into the lungs. The power supply 46 is in the present embodiment therefore adapted to generate and supply a greater amount of power at the commencement of the inspiration phase, as detected by the flow meter 36.

[0024] When attempting to revive the patient from the anaesthetic narcosis it is a disadvantage to have gaseous anaesthetic present on the filter element 38 through which the breathing gas will pass as it is supplied to the patient. Usefully then, the power supply 46 is adapted to energise the emitters 40 in response to a flow signal from the flow meter 36 which indicates gas flow during an expiration phase at the end of an anaesthetic treatment. A signal indicating that it is the end of the anaesthetic treatment may be provided by the ventilator 58 in response to a user input indicating the same. To this end the ventilator 58 is adapted to be operably connectable with the power supply 46. Alternatively the user input may be made in a conventional manner directly on the power supply 46 via a user interface such as a computer keyboard or a dedicated keypad(not shown). The vibrational energy supplied to the filter element 38 from the ultrasound emitters 40 during the expiration phase inhibits adsorption of gaseous anaesthetic from exhaled gas so that little or no gaseous anaesthetic can be desorbed from the filter element 38 into breathing gas in a subsequent inspiration phase.

[0025] It will be appreciated by those skilled in the art that whilst the filter arrangement according to the present invention is described, in relation to Fig. 3 above, in operable connection with an "open" inhalation anaesthetic system the filter arrangement may also be employed in "closed" or "partially closed" circle rebreathing inhalation anaesthetic systems, which are common in the art.

[0026] It will also be appreciated by those skilled in the art that the described embodiments of the present invention may be modified whilst remaining within the scope of the invention as claimed. For example, a vibrational and thermal energy source may be used in combination; or the number of ultrasound emitters may be varied and even a single emitter may be employed and/or the vibratable rods may be omitted.

Claims

1. An anaesthetic filter arrangement comprising a filter housing (2;22) having openings (4,6;24,26) disposed to delimit a gas flow path (4,8,6;24,28,26) internal of the housing (2;22) for gas passing to and from a patient and disposed within the gas flow path (4,8,6;24.28,26) a filter element (10;38) formed of an adsorption material for the alternate adsorption and desorption of gaseous anaesthetic from and into gas passing along the gas flow path (4,8,6;24,28,26) in directions respectively from and to the patient; **characterised in that** the arrangement further comprises an energy source (12,18;40,46)

adapted to supply energy at the filter element (10; 38) to vary retention of the gaseous anaesthetic by the filter element (10;38).

2. An arrangement as claimed in claim 1 **characterised in that** the energy source (12,18) is adapted to supply energy at the filter element (10) to vary the temperature thereof and thereby vary retention of the gaseous anaesthetic by the filter element (10).

3. An arrangement as claimed in claim 2 **characterised in that** the energy source (12,18) comprises an electrical resistive heater (12) disposed in thermal contact with the filter element (10).

4. An arrangement as claimed in claim 2 **characterised in that** the adsorption material forming the filter element (10) is an electrically conducting material and **in that** the energy source comprises an electric power supply (18) connectable to supply electric power to the adsorption material.

5. An arrangement as claimed in claim 1 **characterised in that** the energy source (40,46) is adapted to supply vibrational energy at the filter element (38) and thereby vary retention of the gaseous anaesthetic by the filter element (38).

6. An arrangement as claimed in claim 5 **characterised in that** the energy source comprises an ultrasound emitter (40) disposed to direct ultrasonic vibrational energy towards the filter element (38).

7. An arrangement as claimed in any preceding claim **characterised in that** the energy source (12,18; 40,46) is controllable to supply energy at the filter element (10;38) in synchronism with a gas flow along the gas flow path (4,8,6;24,28,26).

8. An arrangement as claimed in claim 7 **characterised in that** there is further provided a flow meter (36) disposed to monitor gas flow along the gas flow path(4,8,6;24,28,26) and operably connected to the energy source (12,18;40,46) to supply thereto an output indicative of the monitored flow; and **in that** the energy source (12,18;40,46) is adapted to control the supply of energy in response to the output from the flow meter (36).

9. An arrangement as claimed in claim 7 or claim 8 **characterised in that** the energy source (12,18; 40,46) is controllable to supply energy concomitant with gas flow along the flow path (4,8,6;24,28,26) in the flow direction to the patient to promote the desorption of anaesthetic previously adsorbed from gas flowing along the flow path (4,8,6;24,28,26) in the flow direction from the patient.

10. An arrangement as claimed in claim 9 **characterised in that** the energy source (12,18;40,46) is controllable to supply the energy to preferentially promote the desorption from the filter element (10;38) at commencement of gas flow in the flow direction to the patient.

11. An arrangement as claimed in any of the claims 7 to 10 **characterised in that** the energy source (12,18;40,46) is controllable to supply the energy to inhibit the adsorption by the filter element (10;38) of anaesthetic from gas flowing along the flow path (4,8,6;24,28,26) in the flow direction from the patient.

12. An inhalation anaesthetic system comprising a mechanical breathing aid (58,60) for supplying a breathing gas (58) including an anaesthetic gas (60) to ventilate a patient; a gas circuit (52a,b,56) connected to the breathing aid (58,60) for conducting the breathing gas to the patient during an inspiration phase and exhaled gas from the patient during an expiration phase; and an anaesthetic filter arrangement (50) connected to the gas circuit (52a, b,56) and including a filter housing (22) having openings (24,26) delimiting a gas flow path (24,28,26) through the housing (22), and disposed within the gas flow path (24,28,26) a filter element (38) formed of an adsorption material for the alternate adsorption and desorption of gaseous anaesthetic from and into gas passing along the flow path during respectively the expiration phase and the inspiration phase; **characterised in that** the anaesthetic filter arrangement (50) is an arrangement as claimed in any preceding claim.

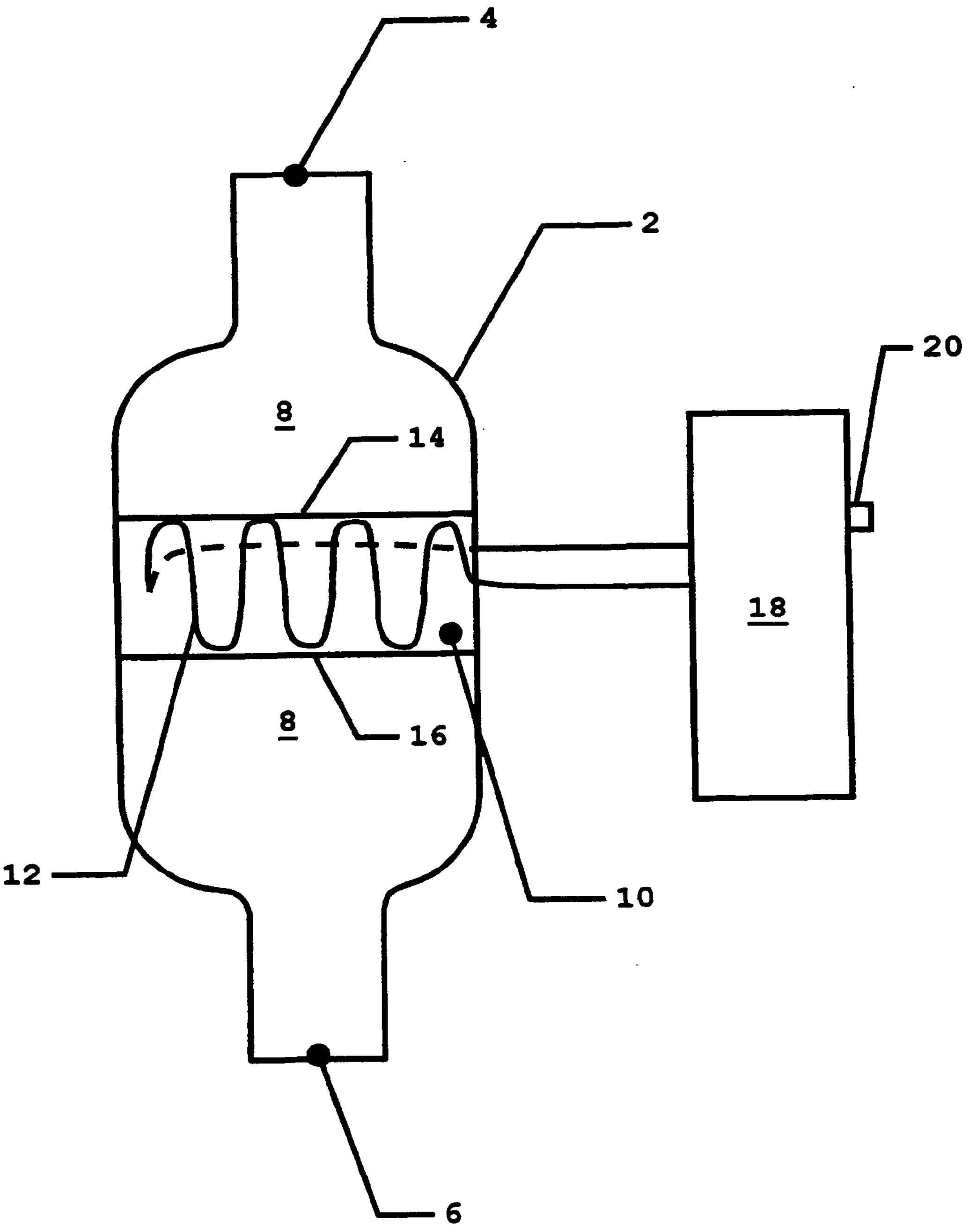

Fig. 1

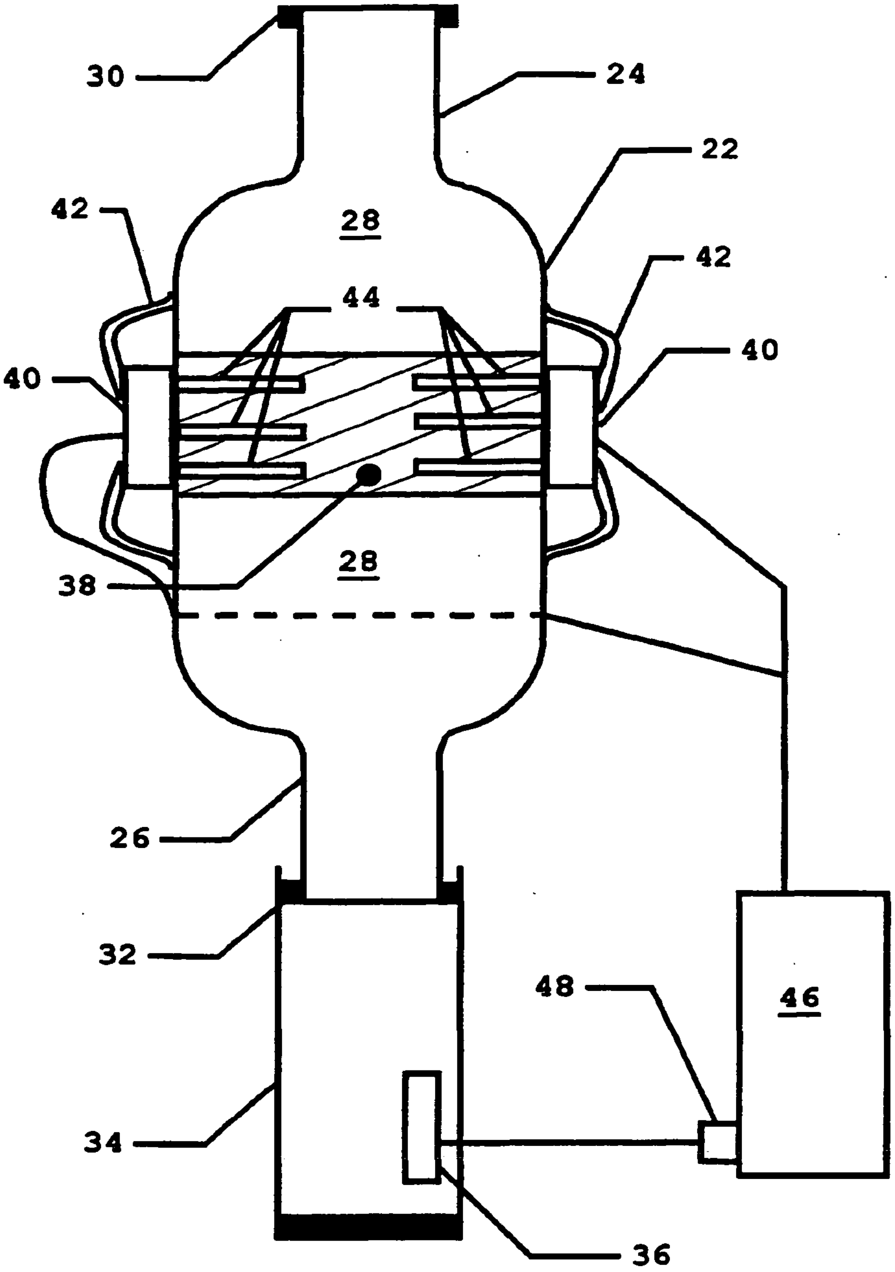

Fig. 2

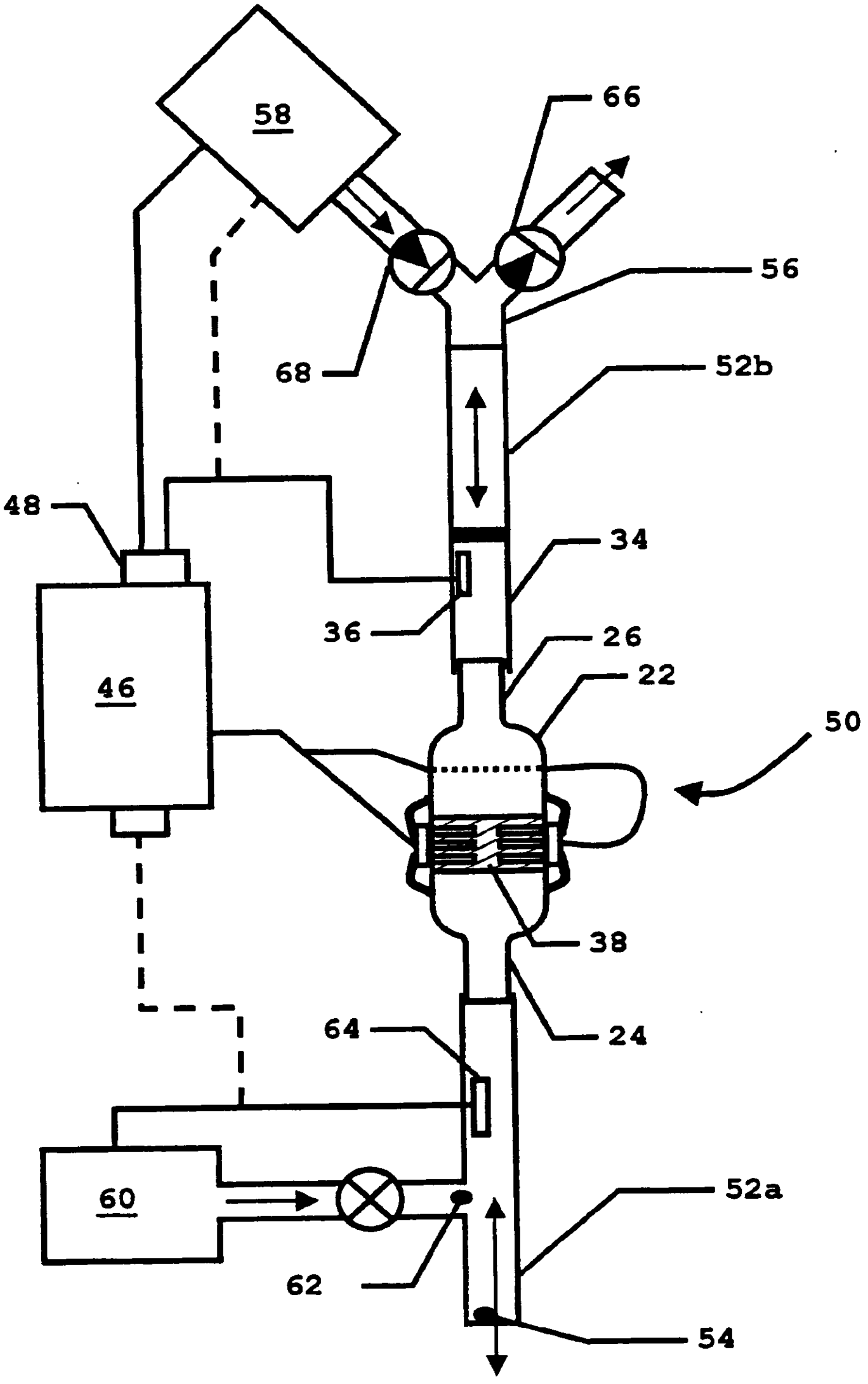

Fig. 3

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(54) **Anaesthetic filter arrangement**

(57) An anaesthetic filter arrangement comprises a filter housing (2) having openings (4,6) disposed to delimit a gas flow path (4,8,6) internal of the housing (2) for gas passing to and from a patient and having disposed within the gas flow path (4,8,6) a filter element (10) formed of an adsorption material for the alternate adsorption and desorption of gaseous anaesthetic from and into gas passing along the gas flow path (4,8,6) respectively from and to the patient. An energy source (12,18) is provided to supply thermal (and/or vibrational) energy at the filter element (10) to vary retention of the gaseous anaesthetic by the filter element (10).

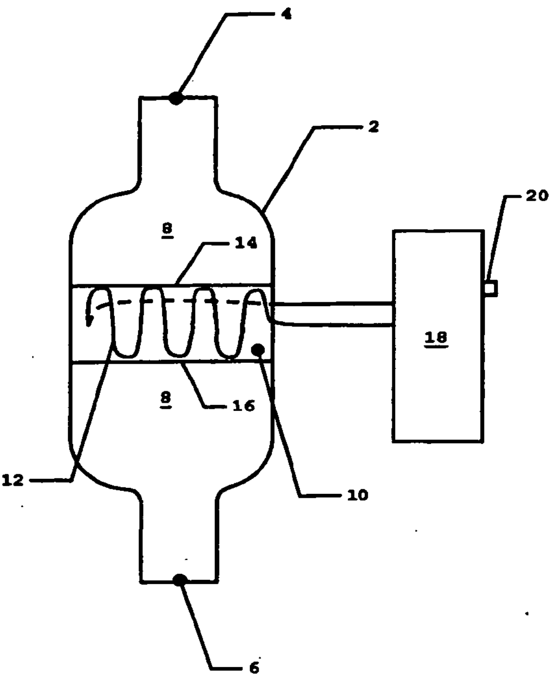

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 01 12 6136

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A	US 5 471 979 A (PSAROS GEORGE ET AL) 5 December 1995 (1995-12-05) * abstract; figure 1 * ---	1-12	
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A	EP 0 284 227 A (UNION CARBIDE CANADA LTD) 28 September 1988 (1988-09-28) * column 9, line 33 - line 36 * ---	1	
A	FR 1 416 169 A (ENGSTROM CARL GUNNAR DANIEL) 29 October 1965 (1965-10-29) * page 1, right-hand column, paragraph 2 - paragraph 4 * -----	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) A61M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	18 November 2003	Valfort, C

CATEGORY OF CITED DOCUMENTS

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